

CLAIMS:

1. A tape-manufacturing system for coating at least one tape substrate, the tape-manufacturing system comprising:

- 5 (a) at least two electron beam (e-beam) deposition sources capable of communicating an evaporant material with at least a portion of at least one tape substrate to deposit a coating thereon; and
- (b) at least one assist source capable of communicating a beam of a species to the coating.

10 2. The tape-manufacturing system according to Claim 1, further including at least one controller in communication with the at least two e-beam deposition sources and the at least one assist source.

3. The tape-manufacturing system according to Claim 2, further including at least one sensor in communication with the at least one controller.

15 4. The tape-manufacturing system according to Claim 3, wherein at least one sensor includes any one of a flow meter, a species monitor, a filament state monitor, a deposition sensor, a temperature sensor, a pressure sensor, a vacuum sensor, a speed monitor, and combinations thereof.

5. The manufacturing process according to Claim 2, wherein the at least one controller is for regulating the at least two e-beam deposition sources.

20 6. The tape-manufacturing system according to Claim 2, wherein the at least one controller is for regulating the at least one assist source.

7. The tape-manufacturing system according to Claim 2, wherein the at least one controller regulates a translational speed of the tape substrate.

8. The tape-manufacturing system according to Claim 1, wherein at least two e-beam deposition sources are spaced so as to create a substantially flat evaporant material flux profile at the surface of the tape substrate.

9. The tape-manufacturing system according to Claim 8, wherein the evaporant material flux profile at the surface of the tape substrate is matched to a species density profile of the assist source at the surface of the tape substrate.

10. The tape-manufacturing system according to Claim 9, wherein the evaporant material profile exhibits an about 10% variation in evaporant material flux along the evaporant material flux profile.

11. The tape-manufacturing system according to Claim 1, wherein the at least two e-beam deposition sources are arranged serially so as to create an elongated coating deposition zone along a length of the tape substrate.

12. The tape-manufacturing system according to Claim 11, wherein the elongated coating deposition zone is at least about 0.6 meters (m).

13. The tape-manufacturing system according to Claim 12, wherein the elongated coating deposition zone is up to about 5 meters (m).

14. The tape-manufacturing system according to Claim 13, wherein the elongated coating deposition zone is between about 0.6 and about 1.2 meters (m).

15. The tape-manufacturing system according to Claim 11, wherein a plurality of e-beam deposition sources are arranged serially so as to create the elongated coating deposition zone along a length of the tape substrate.

16. The tape-manufacturing system according to Claim 1, wherein the at least two e-beam deposition sources comprise a plurality of e-beam deposition sources, at least two of the plurality of e-beam deposition sources arranged serially so as to create an elongated coating deposition and at least two other of the plurality of e-beam deposition sources arranged parallelly to the at least two so as to create a widened elongated coating deposition zone substantially along to a length of the tape substrate.

17. The tape-manufacturing system according to Claim 16, wherein the widened elongated coating deposition zone is at least about 8 centimeters (cm) wide.

18. The tape-manufacturing system according to Claim 17, wherein the widened elongated coating deposition zone is up to about 40 centimeters (cm) wide.

5 19. The tape-manufacturing system according to Claim 18, wherein the widened elongated coating deposition zone is between about 8 and about 20 centimeters (cm) wide.

20. The tape-manufacturing system according to Claim 16, wherein the plurality of e-beam deposition sources are spaced so as to create a substantially flat evaporant material flux profile.

10 21. The tape-manufacturing system according to Claim 20, wherein the evaporant material flux profile at the surface of the tape substrate is matched to a species density profile of the assist source at the surface of the tape substrate.

15 22. The tape-manufacturing system according to Claim 21, wherein the evaporant material profile exhibits an about 10% variation in evaporant material flux along the evaporant material flux profile.

23. The tape-manufacturing system according to Claim 1, wherein a deposition rate of the evaporant material is at least about 1 angstrom per second ($\text{\AA}/\text{s}$).

24. The tape-manufacturing system according to Claim 23, wherein the deposition rate of the evaporant material is up to about 50 angstroms per second ($\text{\AA}/\text{s}$).

20 25. The tape-manufacturing system according to Claim 24, wherein the deposition rate of the evaporant material is between about 1 and about 30 angstroms per second ($\text{\AA}/\text{s}$).

26. The tape-manufacturing system according to Claim 1, further including at least one translation mechanism for moving the at least one tape substrate.

25 27. The tape-manufacturing system according to Claim 1, including at least two assist sources, each capable of providing a beam of a species to bombard the coating.

28. The tape-manufacturing system according to Claim 27, wherein the at least two assist sources are arranged parallelly so that a species density profile of the assist source at the surface of the tape substrate substantially matches an evaporant material flux profile of the at least two e-beam deposition sources at the surface of the tape substrate.

29. The tape-manufacturing system according to Claim 28, further including at least one spacer juxtaposed with respect to the at least two assist sources so as to minimize an overlap at the surface of the tape substrate of the beam of species provided from one assist source with the beam of species provided from another assist source.

30. The tape-manufacturing system according to Claim 28, wherein each assist source is juxtaposed with respect to a surface of the at least one tape substrate so that the bombardment of the coating with the beam of species induces the formation of a biaxially textured coating on the at least one tape substrate.

31. The tape-manufacturing system according to Claim 30, wherein an incident angle of the beam of species with respect to a surface of the at least one tape substrate is between about 30 and 50 degrees.

32. The tape-manufacturing system according to Claim 28, wherein the at least two parallelly arranged assist sources possess mirror symmetry with respect to a longitudinal axis of the at least one tape substrate.

Rule 1.126 33. The tape-manufacturing system according to Claim 27, wherein the at least two assist sources are arranged serially so that a species density profile of the assist source at the surface of the tape substrate matches an evaporant material flux profile of the at least two e-beam deposition sources at the surface of the tape substrate.

34. 33 The tape-manufacturing system according to Claim 34, wherein the serially arranged at least two assist sources are spaced so as to create a substantially flat species density profile at the surface of the tape substrate.

35. 36. The tape-manufacturing system according to Claim 1, wherein the assist source is an ion source.

~~36.~~

~~37.~~ The tape-manufacturing system according to Claim ~~36~~³⁵, wherein the ion source is a radio frequency ion source.

~~37.~~

~~38.~~ The tape-manufacturing system according to Claim 1, further including a collimating grid positioned in spaced relationship to an exit grid of the assist source within the beam of species of the assist source so as to collimate species beamlets.

~~38.~~

~~39.~~ The tape-manufacturing system according to Claim 1, wherein the at least one assist source is juxtaposed with respect to a surface of the at least one tape substrate so that the bombardment of the coating with the beam of species induces the formation of a biaxially textured coating on the least one tape substrate.

~~39.~~

~~40.~~ The tape-manufacturing system according to Claim 8, wherein an incident angle of the beam of species with respect to a surface of the at least one tape substrate is between about 30 and about 50 degrees.

~~40.~~

~~41.~~ The tape-manufacturing system according to Claim 1, wherein the tape-manufacturing system is capable of contemporaneously coating a plurality of sequential portions of the at least one tape substrate.

~~41.~~

~~42.~~ The tape-manufacturing system according to Claim 1, wherein the tape-manufacturing system is capable of contemporaneously coating at least a portion a plurality of tape substrates.

~~42.~~

~~43.~~ An e-beam deposition source useable in a high-temperature superconductor (HTS) coated conductor tape-manufacturing system including at least two e-beam deposition sources capable of communicating an evaporant material on at least a portion of at least one tape substrate to deposit a coating thereon and at least one assist source capable of substantially contemporaneously communicating a beam of a species to the coating, the e-beam deposition source comprising an in-process repairable e-beam deposition source.

~~43.~~

~~44.~~ The e-beam deposition source according to Claim ~~43~~⁴², wherein the e-beam deposition source is substantially self-contained so as to be isolatable from the tape-manufacturing system.

44.

43

~~45~~ The e-beam deposition source according to Claim ~~44~~, further including an isolation mechanism for isolating the e-beam deposition source from the tape-manufacturing system.

45.

44

~~46~~ The e-beam deposition source according to Claim ~~45~~, further including an auxiliary chamber contactingly communicatable with the tape-manufacturing system.

46.

45

~~47~~ The e-beam deposition source according to Claim ~~46~~, wherein the auxiliary chamber is substantially evacuable.

47.

44

~~48~~ The e-beam deposition source according to Claim ~~45~~, where the isolation mechanism further including a closeable passage contactingly communicatable with an atmosphere external to the tape-manufacturing system.

48.

45

~~49~~ The e-beam deposition source according to Claim ~~46~~, wherein the closeable passage is capable of a substantially vacuum tight seal.

49.

48

~~50~~ The e-beam deposition source according to Claim ~~49~~, wherein the e-beam deposition source is interchangeable thereby making the deposition source in-process repairable.

50.

45

~~51~~ The e-beam deposition source according to Claim ~~46~~, wherein the auxiliary chamber further includes a retractor for capable of moving e-beam deposition source to the tape-manufacturing system from auxiliary chamber and back.

51.

42

~~52~~ The e-beam deposition source according to Claim ~~43~~, further including a redundant filament structure.

52.

51

~~53~~ The e-beam deposition source according to Claim ~~52~~, wherein the filament structure includes at least two filaments.

53.

52

~~54~~ The e-beam deposition source according to Claim ~~53~~, wherein the filament structure includes up to six filaments.

54.

53

~~55~~ The e-beam deposition source according to Claim ~~54~~, wherein the redundant filament structure includes four filaments.

55.

51.

~~56~~ The e-beam deposition source according to Claim ~~52~~, further including a filament alignment mechanism for aligning an emitting portion of the filament structure with a directing structure of the e-beam deposition source.

56.

51

~~57~~ The e-beam deposition source according to Claim ~~52~~, further including a filament state monitoring structure.

57.

56

~~58~~ The e-beam deposition source according to Claim ~~57~~, wherein the filament state monitoring structure monitors a resistance of an operational filament.

57.

57

~~59~~ The e-beam deposition source according to Claim ~~58~~, wherein the filament state monitoring structure monitors the resistance of the operational filament by monitoring a current passing through and a voltage across the operational filament.

59.

57

~~60~~ The e-beam deposition source according to Claim ~~58~~, wherein the resistance is the steady-state operational resistance.

60.

51

~~61~~ The e-beam deposition source according to Claim ~~52~~, further including a filament switching mechanism.

61.

60

~~62~~ The e-beam deposition source according to Claim ~~61~~, wherein the filament switching mechanism is triggered by a change in a resistance of an operational filament.

62.

61

~~63~~ The e-beam deposition source according to Claim ~~62~~, wherein the switching mechanism triggers when the resistance of the operational filament is about 120% of an initial steady-state operational resistance of the operational filament.

63.

60

~~64~~ The e-beam deposition source according to Claim ~~61~~, wherein the switching mechanism triggers when there is substantially no change in evaporant material flux with an increase in power provided to an operational filament.

64

~~85~~ A high-temperature superconductor (HTS) coated conductor tape-manufacturing system for coating at least one tape substrate, the tape-manufacturing system comprising:

- (a) at least two in-process repairable e-beam deposition sources capable of communicating an evaporant material with at least one tape substrate to deposit a coating thereon;
- (b) at least one assist source capable of communicating a beam of a species to the coating; and
- (c) at least one controller in communication with the at least two e-beam deposition sources and the at least one assist source.

65

~~86~~ A method for coating at least one tape substrate said method comprising the steps of:

- (a) juxtaposing at least two electron beam (e-beam) deposition sources to be capable of creating an enlarged deposition zone;
- (b) providing at least a portion of at least one tape substrate to the enlarged deposition zone;
- (c) communicating an evaporant material with the at least a portion of at least one tape substrate to deposit a coating thereon;
- (d) communicating a beam of a species to the coating;
- (e) providing at least another portion of at least one tape substrate to the enlarged deposition zone;
- (f) communicating an evaporant material with the at least another portion of at least one tape substrate to deposit a coating thereon;

- (g) communicating the beam of the species to the coating; and
- (h) repeating steps (e) through (g) so as to make the coating along a length of the at least one tape substrate.

5 ⁶⁶
~~67~~ A method for extending the operational capability of a high-temperature superconductor (HTS) coated conductor tape-manufacturing system said method comprising providing at least one electron beam (e-beam) deposition capable of in-process repair.

⁶⁷
~~68~~ A method for coating at least one tape substrate said method comprising the steps of:

- 10 (a) juxtaposing at least two in-process repairable e-beam deposition sources to be capable of creating an enlarged deposition zone;
- (b) providing at least a portion of at least one tape substrate to the enlarged deposition zone;
- (c) communicating an evaporant material with the at least a portion of
15 at least one tape substrate to deposit a coating thereon;
- (d) communicating a beam of a species to the coating;
- (e) providing at least another portion of at least one tape substrate to the enlarged deposition zone;
- (f) communicating an evaporant material with the at least another
20 portion of at least one tape substrate to deposit a coating thereon;
- (g) communicating the beam of the species to the coating; and
- (h) repeating steps (e) through (g) so as to make the coating along a length of the at least one tape substrate.